REMARKS

Claims 1 – 8, 10 – 46, and 68 are currently pending in this application.

Claim Rejections - 35 USC §102

1. A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference. *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). The identical invention must be shown in as complete detail as is contained in the claim. *Richardson v. Suzuki Motor Co.*, 868 F.2d 1226, 1236, 9 USPQ2d 1913, 1920 (Fed. Cir. 1989). See MPEP §2131.

2. Claims 38 – 44 and 46 were rejected under 35 USC 102(a) as being anticipated by Amanuma, U.S. Patent No. 6,188,098 B1, issued February 13, 2001 (hereinafter "Amanuma").

Applicants respectfully traverse the rejections.

Currently pending independent claim 38 essentially contains the limitations of a "multiple layer" hydrogen barrier layer comprising a primary hydrogen barrier layer material and a supplemental hydrogen barrier layer material; the primary and supplemental materials being different from each other; the primary and supplemental materials being either both conducting or both insulating; and the primary hydrogen barrier layer and the supplemental hydrogen barrier layer both inhibit diffusion of hydrogen to the metal oxide material from essentially the same direction over the majority of the length of the shortest one of the primary hydrogen barrier layer and the supplemental hydrogen barrier layer.

The specification specifically describes the structure and function of a "multiple layer" barrier with reference to FIG. 4 at page 17, lines 7 – 22, and with reference to FIG. 7 at page 20, lines 12 – 28. In FIG. 4, multiple layer hydrogen barrier layer 227 comprises supplemental hydrogen barrier layer 229 and primary barrier layer 230. The use of a multiple layer hydrogen barrier has many advantages. It permits a supplemental hydrogen barrier layer 229 that is not fully compatible chemically with the materials of capacitor 226, and in particular metal oxide 216, to be used, because primary barrier layer 230, which is highly compatible chemically with capacitor 226, and in particular metal oxide 216, screens

supplemental barrier layer 229 from direct contact with capacitor 226, and in particular metal oxide 216. It also creates an interface 231 between two dissimilar hydrogen barrier layer materials, which interface is a highly effective trapping site for hydrogen. In FIG. 7, multiple layer hydrogen barrier layer 391 includes primary barrier layer 395 and supplemental barrier layer 393.

The relative positions of a primary barrier layer and a supplemental barrier layer in accordance with the invention are defined in currently pending independent claim 38 with the relatively long phrase: "the primary hydrogen barrier layer and the supplemental hydrogen barrier layer both inhibit diffusion of hydrogen to the metal oxide material from essentially the same direction over the majority of the length of the shortest one of the primary hydrogen barrier layer and the supplemental hydrogen barrier layer". This phrase also prevents claim 38 from accidentally reading on Amanuma in the small places where different barrier layers, essentially intended to protect the metal oxide from hydrogen diffusion from different directions, slightly overlap.

In addition to the structural limitations defined in pending claim 38, and illustrated in FIGS. 4 and 7, pending claim 38 includes the limitations that the primary and supplemental materials are either both conducting or both insulating. A third limitation is that the primary and supplemental materials are different.

In contrast, Amanuma teaches combinations of hydrogen barrier layers that have one of the limitations of pending claim 38 discussed here, but never both limitations. For example, Amanuma, with reference to FIGS. 1 – 9, at column 6, teaches first hydrogen barrier film 7 and non-adjacent hydrogen barrier film 12, which are both nonconductive and comprise the same material, namely, Si_3N_4. Nevertheless, nonconductive first hydrogen barrier film 7 of FIG. 1 inhibits diffusion of hydrogen in the upwards direction to metal oxide material 9, whereas nonconductive hydrogen barrier film 12 inhibits diffusion of hydrogen from the downwards or sidewards direction into metal oxide material 9. As another example, Amanuma, at column 7 with reference to FIGS. 10 – 12, teaches hydrogen barrier layer 11 and hydrogen barrier layer 12 that are adjacent in the sense of claim 38 of the present invention and inhibit hydrogen diffusion from the same direction into metal

oxide material 9, but hydrogen barrier 11 is conducting, while hydrogen barrier 12 is insulating (nonconductive). With reference to FIGS. 15 – 25 at columns 8 and 9, Amanuma teaches hydrogen barrier layer 7 and hydrogen barrier layer 11 that are adjacent in the sense of claim 38 of the present invention, but hydrogen barrier 7 is nonconductive, while hydrogen barrier 12 is conductive. Similarly, with reference to FIG. 29 at column 2, Amanuma describes hydrogen barrier layer 11 and hydrogen barrier layer 12, which protect against hydrogen diffusion in the same direction towards metal oxide film 9, but hydrogen barrier layer 11 is conductive, while hydrogen barrier layer 12 is nonconductive.

A fundamental distinction for understanding the difference between the invention of pending claim 38 and the hydrogen diffusion barrier layers disclosed in Amanuma is that the hydrogen barrier layer of pending claim 38 is functionally a multilayer hydrogen barrier layer having multiple layers that provide improved compatibility with other integrated circuit layers. In contrast, the function of the combination of a plurality of hydrogen barrier layers in Amanuma is simply to envelop completely the ferroelectric or dielectric metal oxide thin film. Whenever two adjacent hydrogen barrier films in Amanuma protect against hydrogen diffusion from the same direction, one hydrogen barrier film is electrically conductive, and the other hydrogen barrier film is electrically insulating.

In summary, Amanuma does not disclose each and every element as set forth in pending independent claim 38 and, therefore, does not anticipate claim 38. Claims 39 – 46 and 68 depend from independent claim 38 and are likewise not anticipated by Amanuma.

Rejections Under 35 USC §103

3. To establish a prima facie case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all of the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d

1438 (Fed.Cir. 1991). MPEP 2142 and MPEP 2143 - 2143.03.

Also, if a proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification. MPEP 2143.01, citing *In re Gordon*, 733 F.2d 900, 221 USPQ 1125 (Fed. Cir. 1984).

Furthermore, if the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims *prima facie* obvious. MPEP 2143.01, citing *In re Ratti*, 270 F.2d 810, 123 USPQ 349 (CCPA 1951).

4. Claims 1 – 4, 10 – 12, 20 – 22, 28 – 30, and 36 were rejected under 35 USC 103(a) as being unpatentable over Kanaya, U.S. Patent Application Publication No. U.S. 2002/0038402 A1, published March 28, 2002 (hereinafter "Kanaya") in view of Shimada et al., U.S. Patent No. 6,351,004 B1, issued February 26, 2002 (hereinafter "Shimada").

Applicants respectfully traverse the rejections.

In view of the affidavit of the inventors under 37 CFR 1.131 showing prior invention and diligence before the effective date of the Kanaya reference, September 10, 2001, these rejections should be withdrawn.

Even if Kanaya were available as a reference, however, the claims would be nonobvious and patentable over the proposed combination of Kanaya and Shimada.

Currently pending claim 1 includes a limitation that the hydrogen barrier layer comprises a material selected from the group consisting of strontium tantalate, bismuth tantalate, and tantalum oxide. Similarly, currently pending independent claim 28 includes a limitation that the hydrogen barrier layer comprises a material selected from the group consisting of strontium tantalate, bismuth tantalate, and tantalum oxide.

In the Office Action dated June 16, 2003, the Examiner wrote that Shimada discloses "a hydrogen barrier film that comprises one of silicon oxide, strontium tantalate or strontium titanate, wherein one of these materials is used for the disclosed intended purpose of preventing the oxidation of the conductive layers surrounding the metal oxide material." Applicants recognize that the rationale for combining references need not be

identical with the rationale in the present application. See, e.g., MPEP 2144. Nevertheless, Applicants disagree with Examiner's analysis of the Shimada reference. Furthermore, Applicants maintain that there is no suggestion or motivation in the references to combine them.

The Examiner did not specify the parts in Shimada to which reference was made; however, Applicants assume that the relevant section of the Shimada reference includes the discussion of FIG. 5 beginning at column 4, line 40. Shimada discloses a second insulating layer 8, such as SiO_2, $SrTa_2O_8$, SeO_2, or $SrTiO_3$, and a floating electrode 9 interposed between source 3, insulator 5, and drain 4 on one side, and ferroelectric layer 6 on the other side. See Shimada, column 4, lines 44 – 62. Shimada teaches that floating electrode 9 is provided to keep the ferroelectric layer 6 from direct contact with source 3 and drain 4. See Shimada, column 4, lines 49 – 51. Floating electrode 9 prevents oxidation in source 3 and drain 4 by preventing contact of oxide ferroelectric layer 6 with source 3 and drain 4. See Shimada, column _, lines 51 – 54. Floating electrode 9 also helps stabilize growth of ferroelectric crystalline material. See Shimada, column 4, lines 54 – 61. Shimada does not say that second insulating layer 8 prevents oxidation of source 3 and drain 4. See Declaration of Larry D. McMillan (hereinafter "McMillan Declaration"), ¶6. In fact, it is not inherently clear that an oxide second insulating layer 8 as disclosed in Shimada would protect against oxidation. See McMillan Declaration, ¶7. Also, Shimada does not mention or discuss using second insulating layer 8 as a hydrogen barrier layer. See McMillan Declaration, ¶8. Furthermore, even if second insulating layer 8 of Shimada were disclosed as a layer to protect against oxidation, there is no suggestion in Shimada or in the art in general that an element that protects against oxidation protects against hydrogen diffusion. See McMillan Declaration, ¶9.

It should be noted that the present application, with reference to FIG. 6 at page 20, lines 1 – 11, teaches an integrated circuit MFMISFET 340 having a floating gate electrode 354, over conductive hydrogen barrier layer 352 in accordance with the invention, which overlies gate insulator 350 covering source/drain regions 344 and 348. MFMISFET 340 comprises both a hydrogen barrier layer and an insulating layer between floating gate

electrode 354 and source/drain regions 344, 348. Furthermore, hydrogen barrier layer 352 in FIG. 6 is electrically conductive, whereas a hydrogen barrier layer comprising a material selected from the group consisting of strontium tantalate, bismuth tantalite, and tantalum oxide, as defined in claims 1 and 28 of the present invention, are generally electrically insulating. See McMillan Declaration, ¶10. Thus, MFMISFET 340 is quite distinct from the device depicted in FIG. 5 of the Shimada reference.

In the Shimada reference, the purpose and the principle of operation of second insulating layer 8 is its role as an electrical insulator between floating electrode 9 on one side and source 3, drain 4, and tunnel-barrier insulator 5 on the other side. The only discussion in Shimada concerning second insulating layer 8 relates to the permittivity of second insulating layer 8. See Shimada, column 4, line 63 to column 5, line 5. Shimada explains that it is preferable to choose a material of high permittivity such as $SrTa_2O_6$ (strontium tantalate) because ferroelectric layer 6 and second insulating layer 8 are equivalent to two capacitors in series. See Shimada, column 4, line 63 to column 5, line 5. Permittivity is directly related to the dielectric constant of a material by the equation:

$$\epsilon = K\epsilon_o,$$

where ϵ is permittivity, K is a relative dielectric constant, and ϵ_o is the permittivity of a vacuum. See McMillan Declaration, ¶12. It is well-known in the art that the insulating properties, the dielectric constant, and thereby the permittivity of a metal oxide material, such as $SrTa_2O_6$, decreases when the oxide is partially reduced by hydrogen, resulting in a non-oxide material replacing some of the oxide material. See McMillan Declaration, ¶13. It is also well-known in the art that a layer of metal oxide, such as $SrTa_2O_6$, that functions as a hydrogen diffusion barrier functions by "gettering" hydrogen atoms as they diffuse into the metal oxide. See McMillan Declaration, ¶11, 14. The hydrogen atoms reduce some of the oxygen atoms of the oxide and thereby reduce the insulating characteristic and permittivity of the layer. See McMillan Declaration, ¶15.

Accordingly, an insulating layer of metal oxide, such as strontium tantalate ($SrTa_2O_6$), is useful in an integrated circuit either as a hydrogen barrier (as disclosed in the present application) or alternatively as an electrically insulating layer having high

permittivity, but not as both. See McMillan Declaration, ¶16. If an insulating layer of metal oxide $SrTa_2O_6$ were used in an integrated circuit as a hydrogen diffusion barrier layer subjected to reductive process conditions involving reactive hydrogen atoms, some of the oxide would be reduced to a different, non-oxide compound and the resulting material would be unsatisfactory for its intended purpose of being a high-permittivity dielectric insulator. See McMillan Declaration, ¶17.

The principle of operation of a metal oxide hydrogen barrier layer in accordance with the present invention, such as strontium tantalate, is that some of the oxide is virtually sacrificed in its reaction with reactive hydrogen atoms during fabrication, and thereby has no functional role during actual operation of the integrated circuit. See McMillan Declaration, ¶18. In contrast, the principle of operation of a metal-oxide second insulating layer 8 in the Shimada reference is to function as a metal-oxide insulator during actual operation of the integrated circuit. See McMillan Declaration, ¶19. Therefore, if second insulating layer 8 of Shimada were modified to serve as a hydrogen barrier layer in accordance with the present invention, at least a portion of the metal oxide would be reduced during fabrication processes, thereby changing the principle of operation of metal-oxide second insulating layer 8. See McMillan Declaration, ¶20.

Therefore, the combination of Kanaya and Shimada does not teach or suggest all of the claim limitations of independent claims 1 and 28, in particular, the limitation that the hydrogen barrier layer comprises a material selected from the group consisting of strontium tantalate, bismuth tantalate, and tantalum oxide. Furthermore, because using second insulating layer 8 of Shimada as a hydrogen barrier layer would render second insulating layer 8 unsatisfactory for its intended purpose in Shimada, there is no suggestion or motivation to make the modification proposed by the Examiner. Finally, the proposed combination of Kanaya and Shimada to use second insulating layer 8 of Shimada as a hydrogen barrier layer would change the principle of operation of second insulating layer 8. For these reasons, it is believed that pending independent claims 1 and 28 are not obvious over Kanaya in view of Shimada. Since claims 2 – 8, 10 – 27, and claims 29 – 37 depend from claims 1 and 28, respectively, it is believed that these dependent claims are also not

obvious.

5. Claims 5 – 8, 13, 17, 18, 23 – 27, 31, 35, and 37 were rejected under 35 USC 103(a) as being unpatentable over Kanaya, U.S. Patent Application Publication No. U.S. 2002/0038402 A1, in view of Shlmada et al., U.S. Patent No. 6,351,004 B1, and further in view of Amanuma, U.S. Patent No. 6,188,098 B1.

Applicants respectfully traverse the rejections.

Claims 5 – 8, 13, 17, 18, and 23 – 27 depend from independent claim 1, and claims 31, 35, and 37 depend from independent claim 28. As argued above in item 4, it is believed that independent claims 1 and 28 are not obvious; therefore, claims 5 – 8, 13, 17, 18, and 23 – 27 and claims 31, 35, and 37 depending from them are also not obvious.

6. Claim 45 was rejected under 35 USC 103(a) as being unpatentable over Amanuma as applied to claims 38 – 44 and 46 above, and further in view of Shimada.

Applicants respectfully traverse the rejection.

As explained in item 2 above, it is believed that Independent claim 38 is not anticipated by Amanuma, and is therefore patentable. Claim 45 depends from claim 38, and is therefore also patentable.

For the above reasons, pending claims 1 – 8, 10 – 18, 20 – 46, and 68 are believed to be patentable and their reconsideration and allowance are respectfully requested. It is believed no fee is due. If any fees are due, the Commissioner is authorized to charge them to Deposit Account No. 50-1848.

Respectfully submitted,
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